sPHENIX Report

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The sPHENIX event display of cosmic candidates in MVTX+INTT+TPOT

MVTX, INTT, and TPOT sub-detector groups

1 Introduction

This supporting document describes the information for the sPHENIX event displays of cosmic candidates in the three tracking sub-detectors, MVTX, INTT, and TPOT.

2 Data

This analysis used the cosmic run dataset, Run 25475, which was collected with the sPHENIX magnet on. The trigger signal was based on the coincidence of the center of the top and bottom of the Outer HCAL (oHCal). The beam crossing counters (BCO) of the oHCal coincidence trigger signal received by the sub-detectors were recorded in data streams and were later used for event synchronization across sub-detectors. The processed and analyzed events had common BCOs for MVTX and TPOT, which were always one BCO greater than those for INTT. Unless otherwise specified, the term BCO in the following text refers to the BCO recorded by INTT for simplicity.

2.1 MVTX

MVTX operated in the streaming readout mode during the data-taking period and continuously collected data independent of oHCal coincidence trigger signals.

All chips were configured such that the average of the signal threshold of the pixels on chips was 100 electrons. A global strobe pulse, generated by the MVTX internal trigger, was used as part of a logical AND on each pixel and allowed readout only when it was coincident with a pixel above the threshold. The MVTX detector was configured to be readout in the continuous mode, with an ≈ 89 μs strobe length, which is the duration for the readout unit to be integrated. Each strobe was assigned a BCO number, MVTX strobe BCO, for internal synchronization.

2.1.1 Location of PRDF

/sphenix/lustre01/sphnxpro/commissioning/MVTX/cosmics/cosmics_mvtx-flx{0..5}-00025475-000{0,1}.evt

2.2 INTT

INTT operated in the trigger readout mode during the data-taking period. The servers output the hit data to downstream only when receiving the trigger signal. The time-in study with the oHCal trigger was performed prior this run. The *n_collisions* 8 and *modebit* 95 were set. The 270 mV was used to all the chips for the signal threshold. In addition, the nominal calibration-based masking files were loaded for hot-channel-masking purpose.

2.2.1 Location of PRDF

/bbox/commissioning/INTT/cosmics/cosmics_intt{0..7}-00025475-0000.evt

2.3 TPOT

TPOT operated in triggered mode for the entire data taking period. The relevant raw data file is at:

/bbox/commissioning/TPOT/cosmics/TPOT_ebdc39_cosmics-00025475-000{0,9}.evt

3 Analysis and plots

3.1 MVTX

The raw data were decoded into pixel hits and saved into ROOT trees. In the ROOT trees, strobes were assembled and aligned using MVTX strobe BCO to synchronize across different staves and FELIX servers.

The isolated pixel hits, which had no adjacent pixel hits, were removed from the analysis. Then, the remaining adjacent hits were grouped to form clusters. The position of each cluster was the arithmetic average of the position of its constituent pixel hits. The position of the pixel hits assumed the ideal geometry from the GEANT4 simulation.

A loose criterion to select events that had at least four clusters, excluding those with noisy pixel hits, was applied. Three cosmic candidates, BCO 883719272337, 884330860848, and 885603848940 are shown in Fig. 1, 2, 3. Each figure shows the cluster position and size, defined as the number of constituent pixel hits, in X-Y plane on the left-hand side and Z-Radius plane on the right-hand side. The radius of the clusters was assigned to be negative if the azimuthal angle $\phi = [-\pi, 0]$.

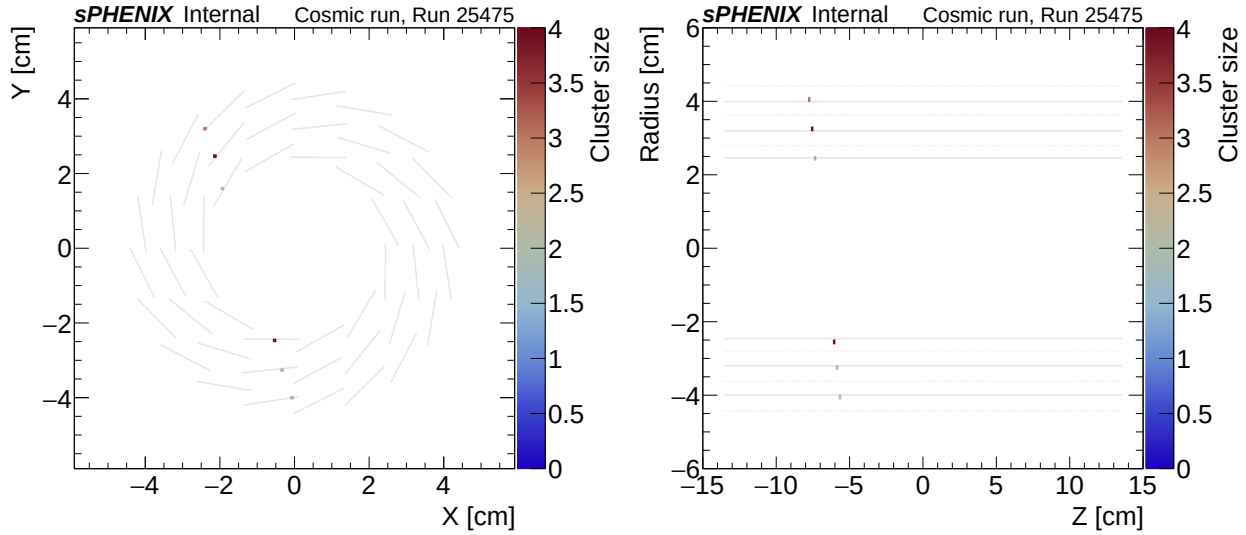

Figure 1: The 2-dimensional event display of the event with BCO 883719272337: (Left) The cluster position and size in X-Y plane. (Right) The cluster position and size in Z-Radius plane.

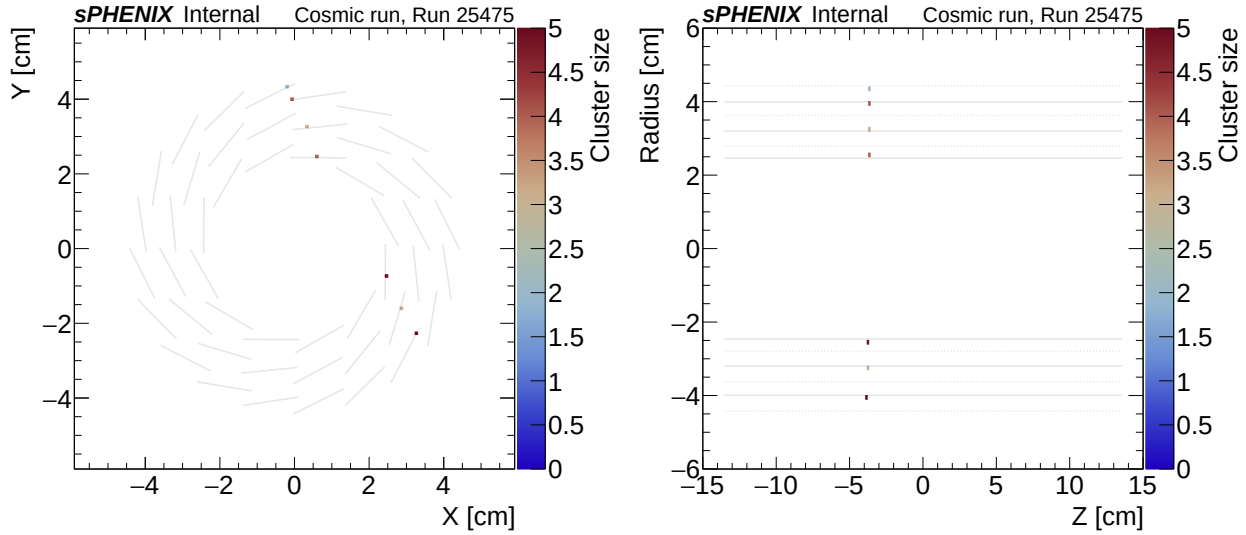

Figure 2: The 2-dimensional event display of the event with BCO 884330860848: (Left) The cluster position and size in X-Y plane. (Right) The cluster position and size in Z-Radius plane.

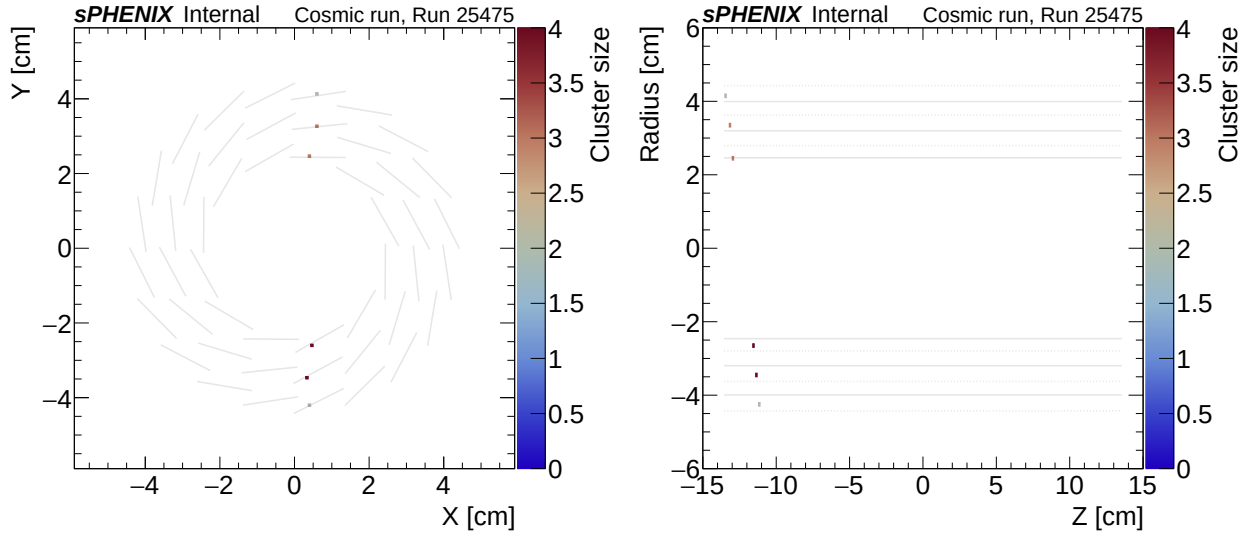

Figure 3: The 2-dimensional event display of the event with BCO 885603848940: (Left) The cluster position and size in X-Y plane. (Right) The cluster position and size in Z-Radius plane.

3.2 INTT

A private decoder was used to convert the raw data into the event-base ROOT trees, server by server. The ROOT files were synchronized based on BCO afterward.

The clustering was performed column by column. The cluster position in xy plane was determined by pos $= \Sigma_i E_i \cdot \text{pos}_i / \Sigma_i E_i$, where E is the energy deposit quantified by the 3-bit INTT chip, pos is x or y. In the channel-to-position step, the INTT geometry considers the rough systematic offset among the INTT halves. Noting that, the INTT alignment correction is not finalized yet.

In the analysis, some known hot spots were masked. The clusters with cluster size greater than 4 were removed. In addition, the events with at least two clusters in the inner layer, and so as the outer layer, was applied to select the cosmic-like events. Fig. 4, 6, 8 present three cosmic candidates with BCO 883719272337, 884330860848 and 885603848940. The X-Y plane and Z-Radius plane are both shown. The negative radius represents the clusters with the azimuthal angles $\phi = [-\pi, 0]$. Due to the strip length of INTT, 16 mm in z axis $\pm$ 13 cm region and 20 mm for the rest region, the event display in the Z-Radius plane may not seem to be a straight line. The optimized event-display module specified for the INTT, which gives the 3D view of INTT sensor geometry, has been developed, as shown in the Fig. 5, 7, 9.

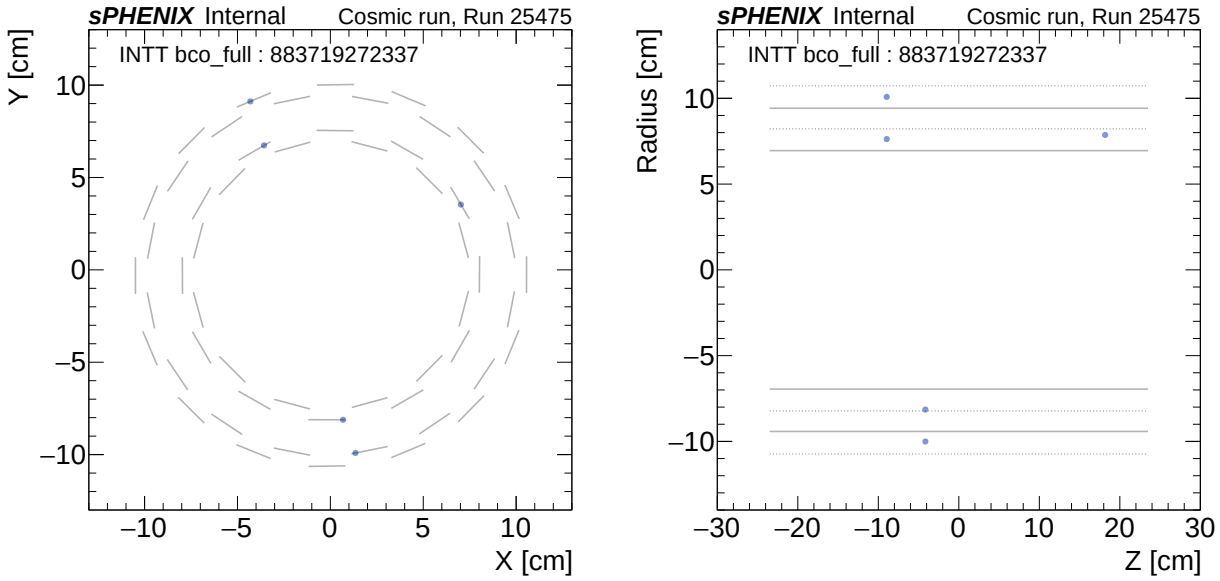

Figure 4: The 2-dimensional event display of the event with BCO 883719272337: (Left) The cluster position in X-Y plane. (Right) The cluster position in Z-Radius plane.

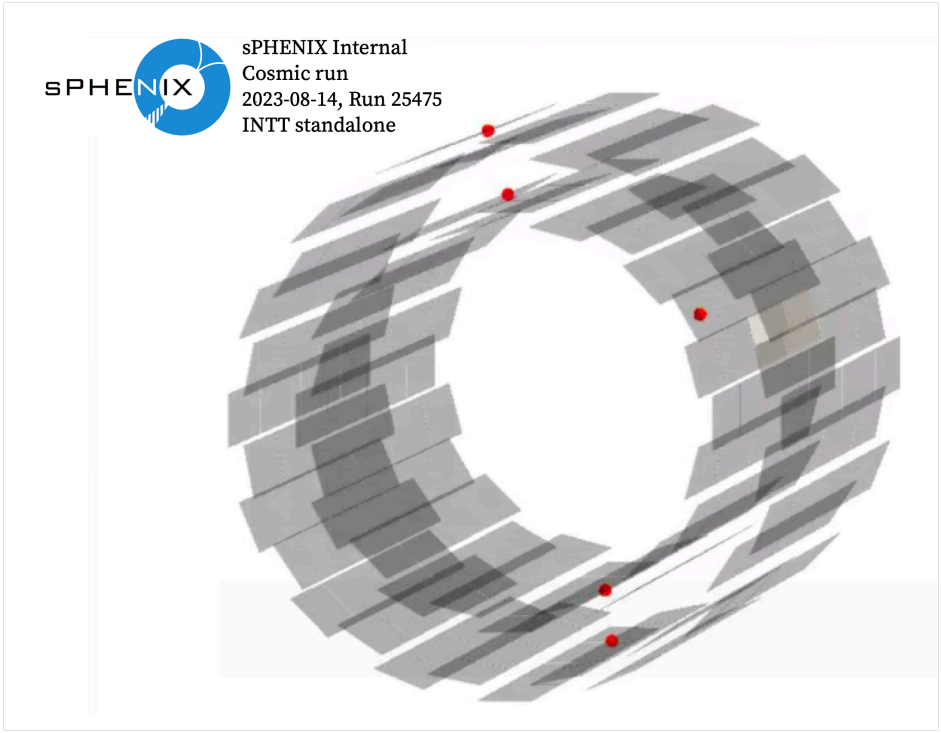

Figure 5: The 3-dimensional event display of the event with BCO 883719272337. The figure is provided by the INTT-specified event-display module.

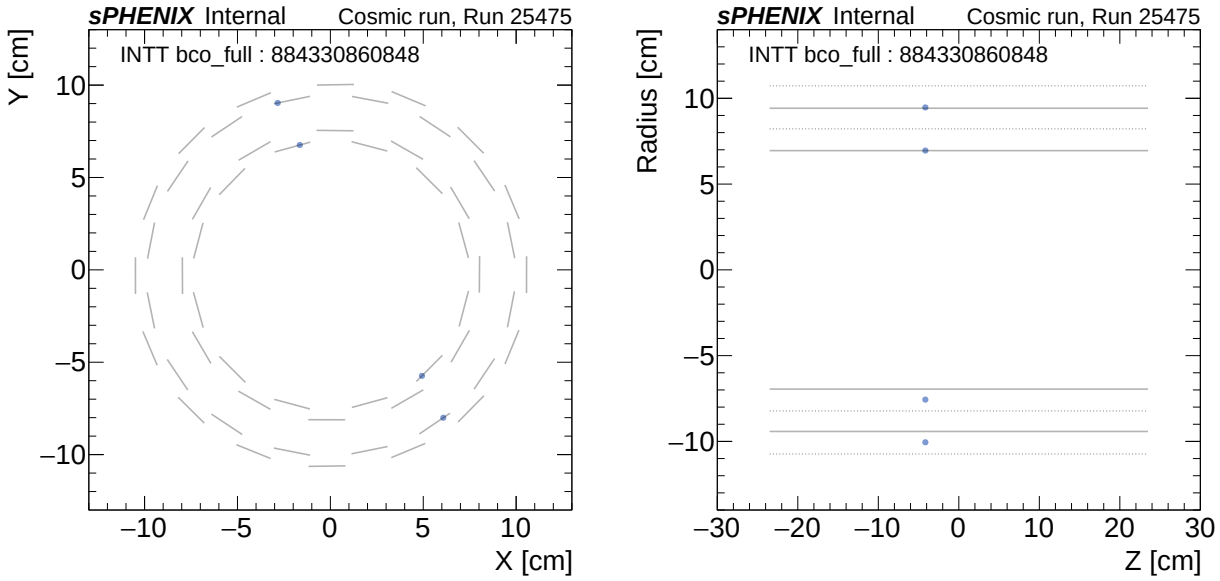

Figure 6: The 2-dimensional event display of the event with BCO 884330860848: (Left) The cluster position in X-Y plane. (Right) The cluster position in Z-Radius plane.

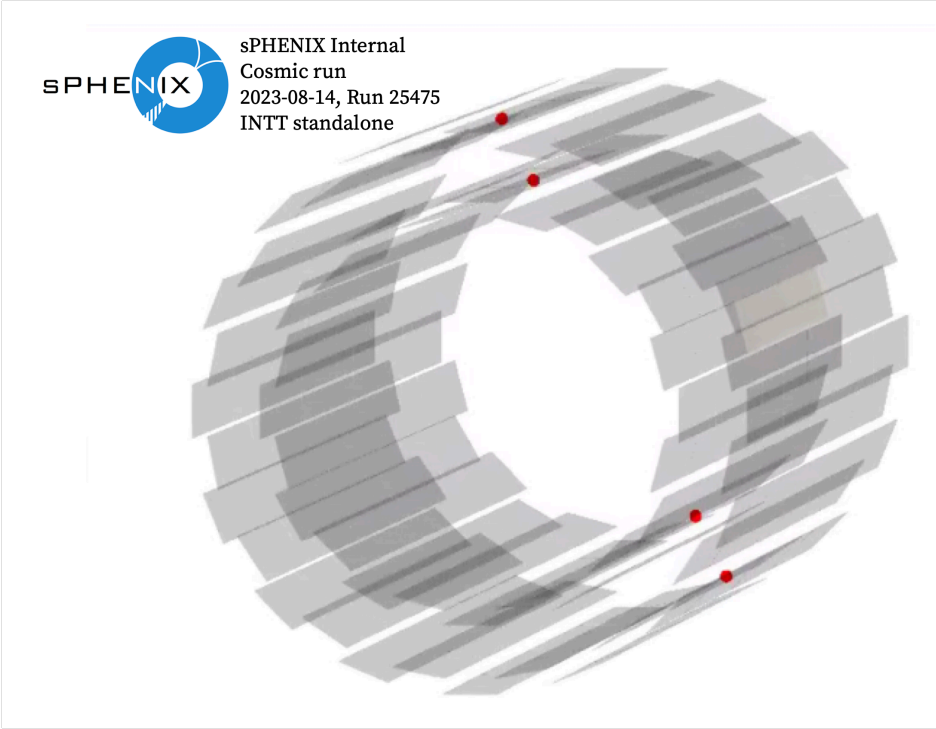

Figure 7: The 3-dimensional event display of the event with BCO 884330860848. The figure is provided by the INTT-specified event-display module.

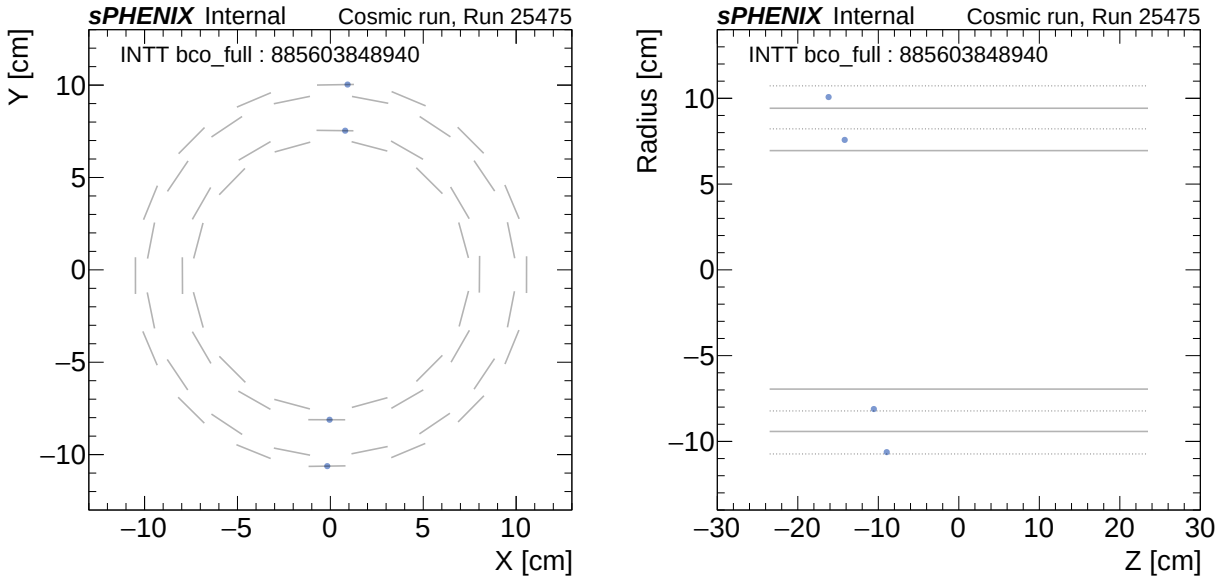

Figure 8: The 2-dimensional event display of the event with BCO 885603848940: (Left) The cluster position in X-Y plane. (Right) The cluster position in Z-Radius plane.

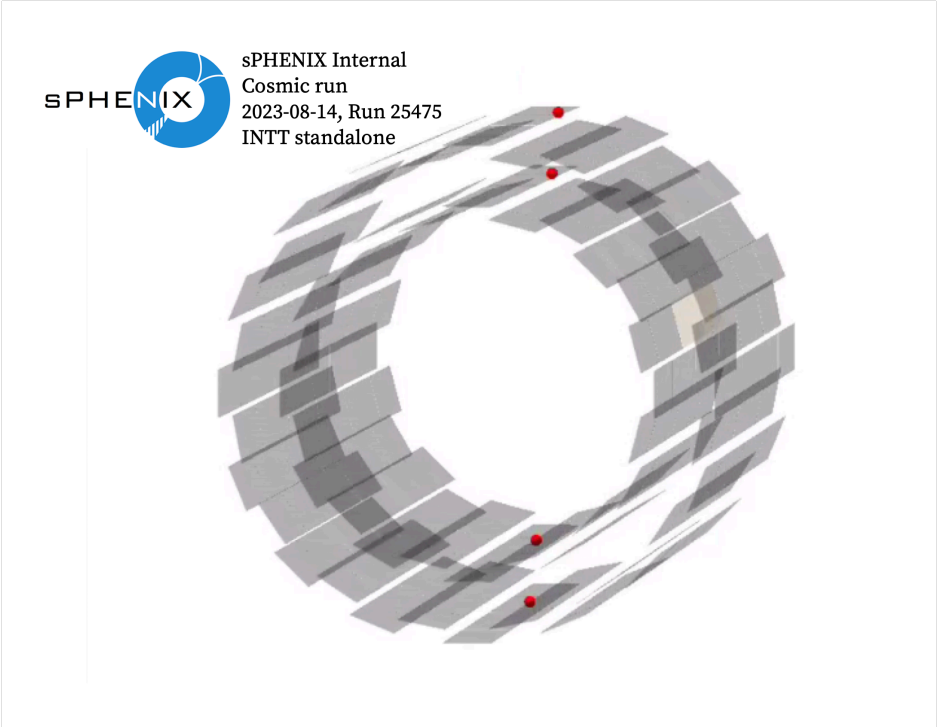

Figure 9: The 3-dimensional event display of the event with BCO 885603848940. The figure is provided by the INTT-specified event-display module.

Fig. 10 to 12 show the 2-dimension display of the three cosmic candidates, BCO 883719272338, 884330860849, and 885603848941 with MVTX and INTT.

The position of clusters was written to a JSON file, which was then passed to the sPHENIX Event Display website (https://www.sphenix.bnl.gov/edisplay/) to produce 3-dimensional event display. Fig. 15, 14, and 15 show the sPHENIX-style 3-dimension event display of the three cosmic candidates seen in MVTX and INTT.

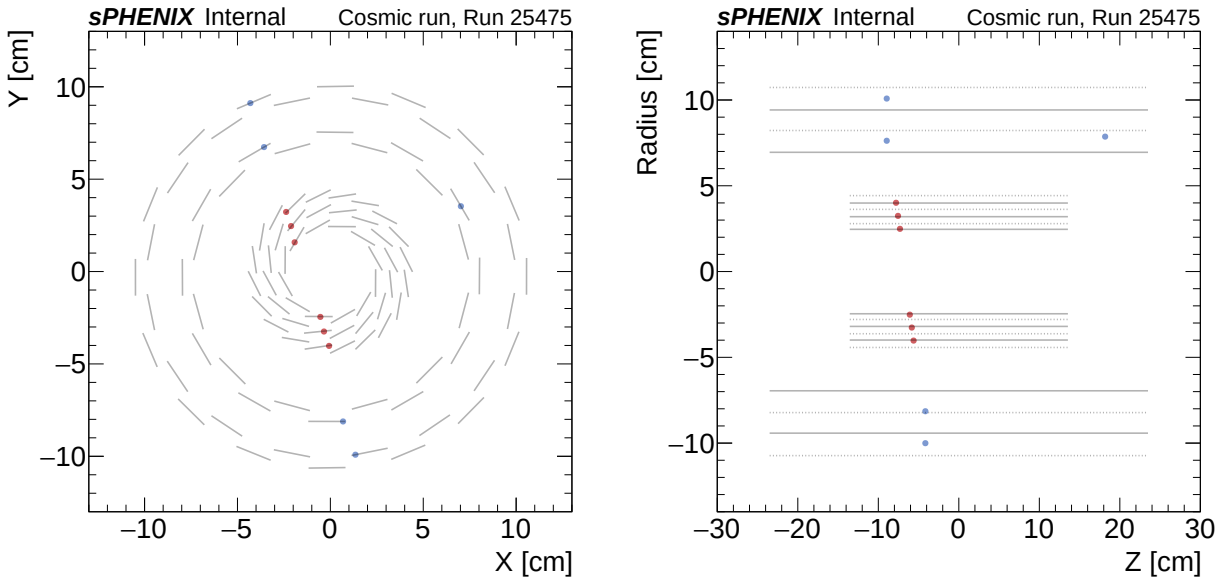

Figure 10: The 2-dimensional event display of MVTX and INTT of the event with INTT BCO 883719272337: (Left) The cluster position and size in X-Y plane. (Right) The cluster position and size in Z-Radius plane.

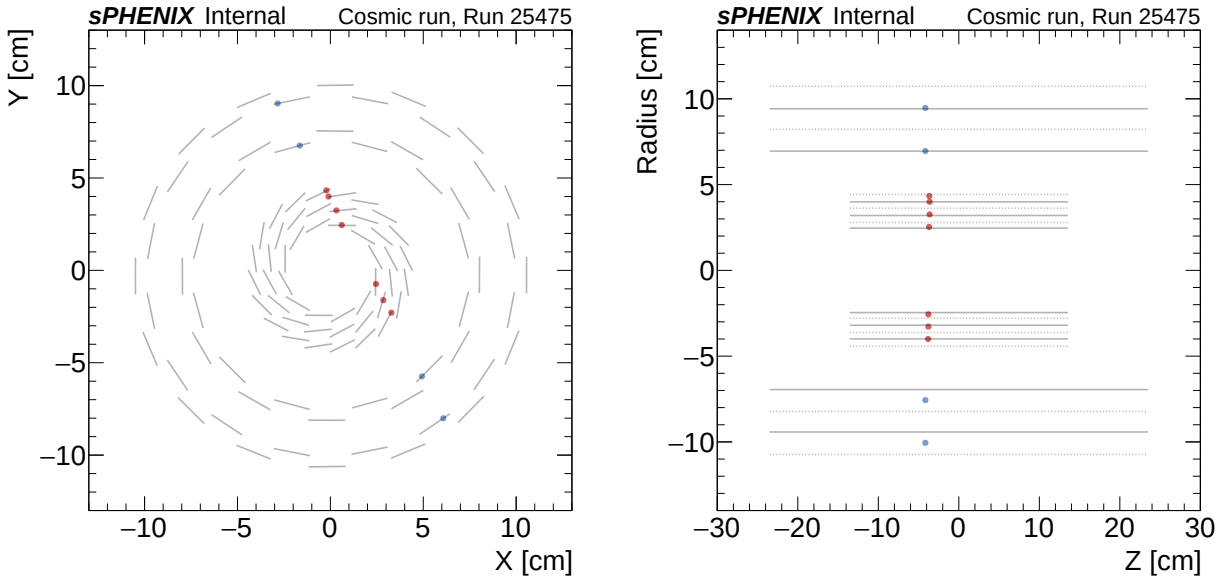

Figure 11: The 2-dimensional event display of MVTX and INTT of the event with INTT BCO 884330860848: (Left) The cluster position and size in X-Y plane. (Right) The cluster position and size in Z-Radius plane.

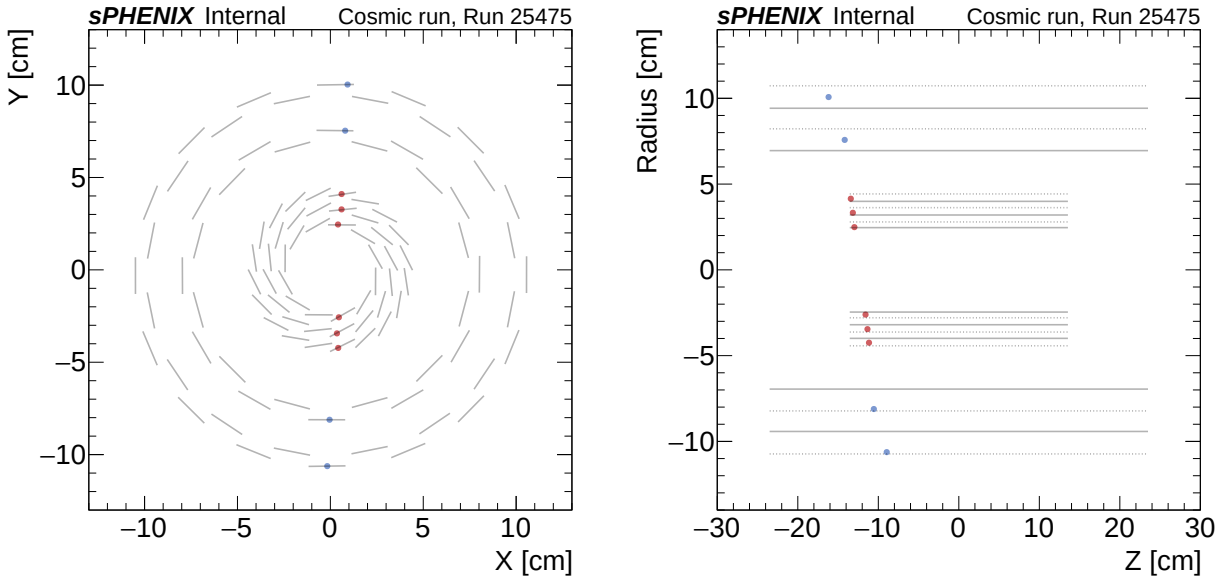

Figure 12: The 2-dimensional event display of MVTX and INTT of the event with INTT BCO 885603848940: (Left) The cluster position and size in X-Y plane. (Right) The cluster position and size in Z-Radius plane.

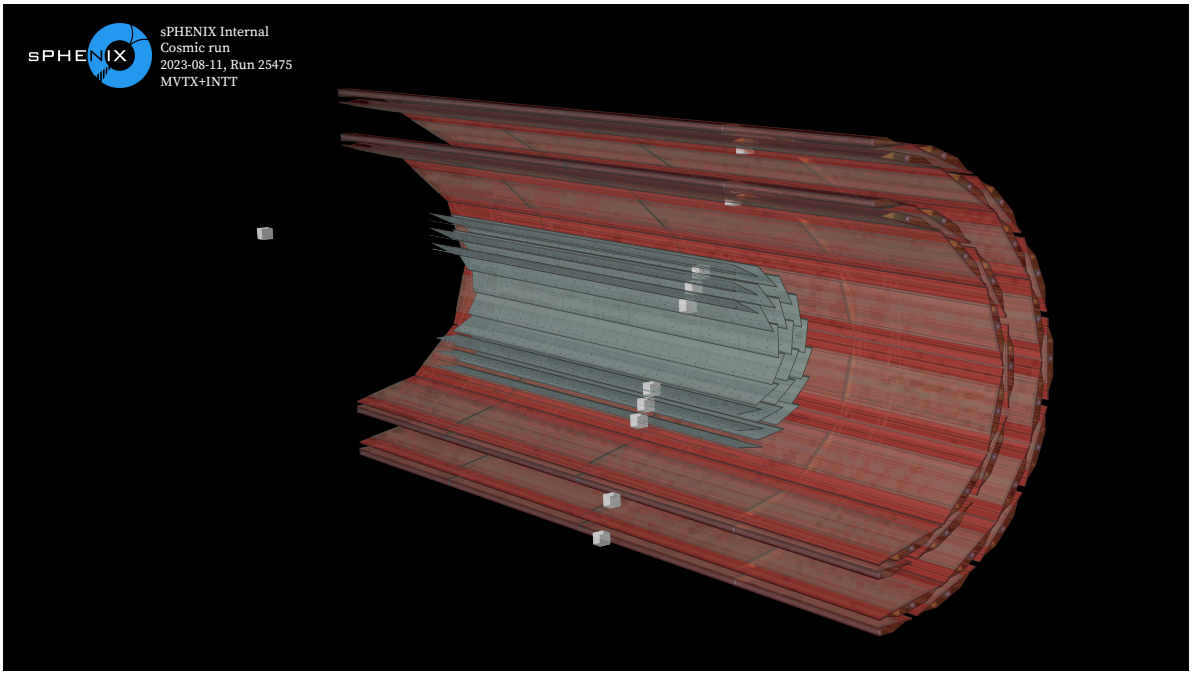

Figure 13: The 3-dimensional event display of MVTX and INTT of the event with BCO 883719272337.

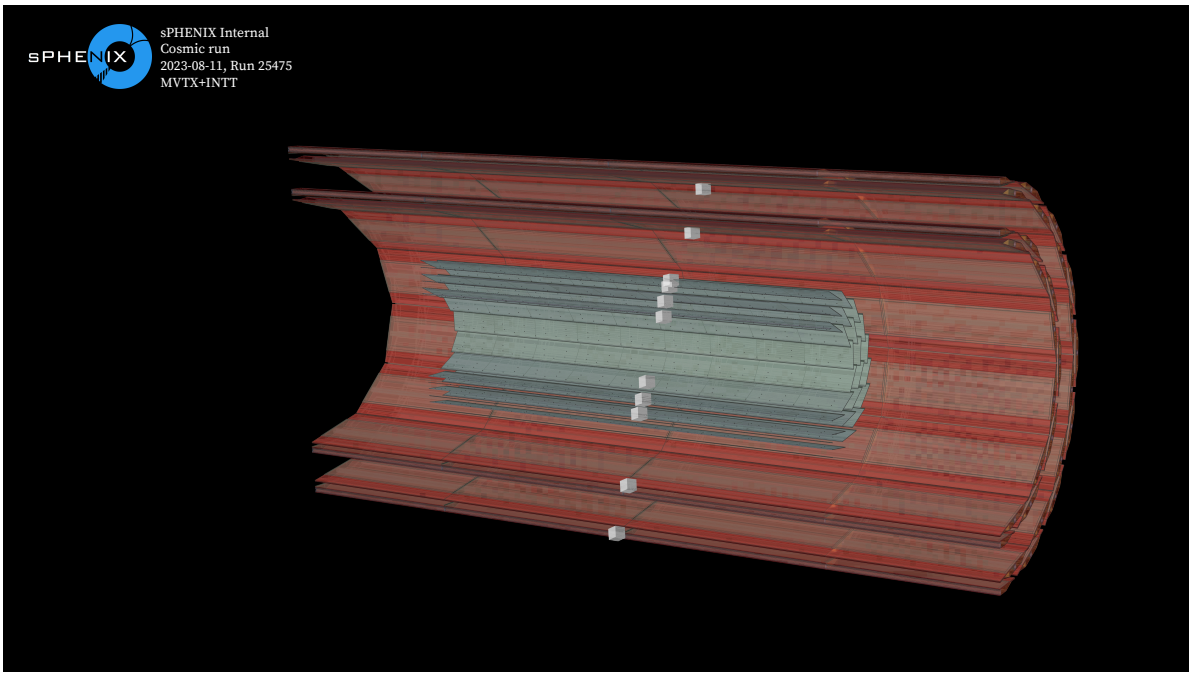

Figure 14: The 3-dimensional event display of MVTX and INTT of the event with BCO 884330860848.

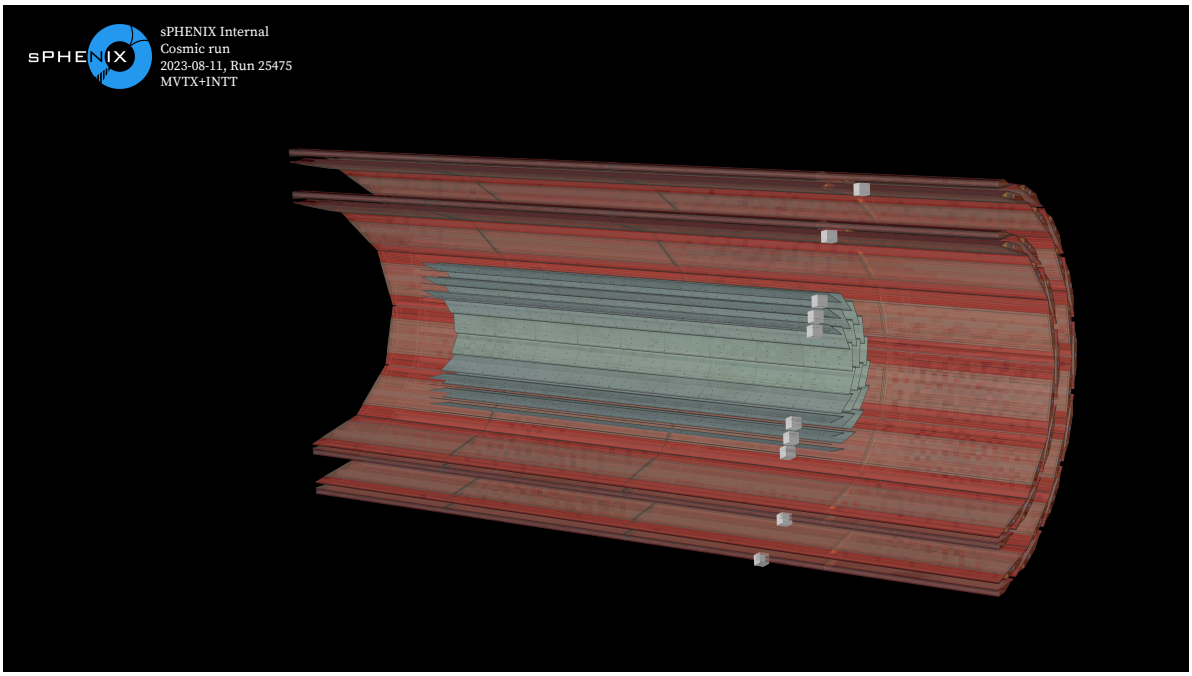

Figure 15: The 3-dimensional event display of MVTX and INTT of the event with BCO 885603848940.

3.3 TPOT

TPOT raw data is decoded using fun4all and the resulting calibrated hits are stored into a dedicated evaluation TTree. Because the data of a given trigger are split across several (typically 2 to 3) adjacent RCDaq events, one must first re-assemble full events. This is achieved outside of fun4all and using the evaluation tree.

Once full events are assembled, clusters are built using a simple clustering algorithm that consist in grouping all hits above threshold on adjacent strips. Cluster positions are then calculated using the centroid of the constituting strips position weighted by the collected charge on each strip, and the resulting position is stored in a second dedicated evaluation tree. The content of this tree is what is used for the following event display.

It is important to note that unlike the other two subsystems, TPOT does not measure 3D space point per se. TPOT consists of two layers, one measuirng a position in the (r, ϕ) plane (layer 55) and the second in the (r, z) plane (layer 56). For the other coordinate (z and ϕ respectively), the cluster is arbitrarily placed at the middle of the strip, with a very large uncertainty (namely the length of the strip over $\sqrt{12}$).

The MVTX, INTT, and TPOT sub-detectors have different geometric acceptances, which means that not all cosmic candidates detected by MVTX and INTT also produced clusters in TPOT. Hence, three different cosmic candidates, BCO 883479809083, 883639102957, and 885740684584, that had clusters in all three sub-detectors were selected and displayed in Fig. 16, 17, and 18. After removing outliers in the INTT manually, the remaining clusters are fit with an helix, and an estimate of the transverse momentum is obtained from the curvature, assuming a uniform magnetic field along z of 1.4T.

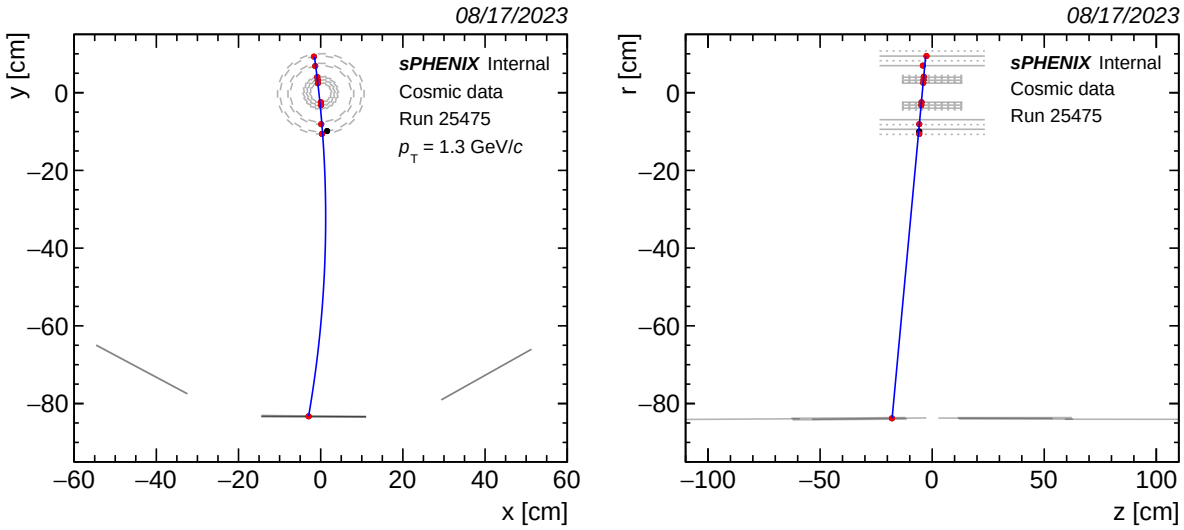

Figure 16: The 2-dimensional event display of MVTX, INTT, and TPOT of the event with BCO 883479809083: (Left) The cluster position and size in X-Y plane. (Right) The cluster position and size in Z-Radius plane.

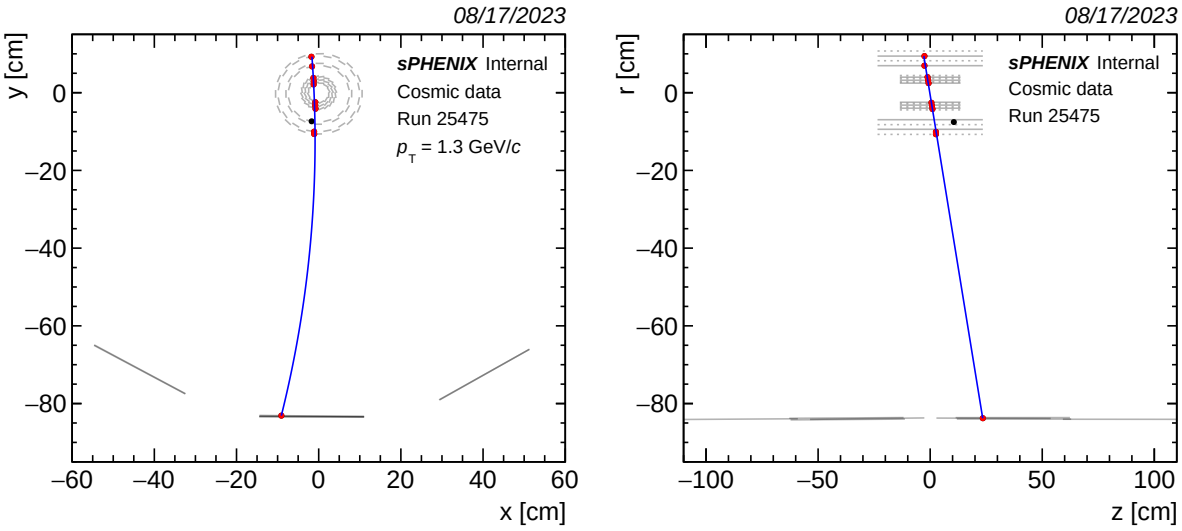

Figure 17: The 2-dimensional event display of MVTX, INTT, and TPOT of the event with BCO 883639102957: (Left) The cluster position and size in X-Y plane. (Right) The cluster position and size in Z-Radius plane.

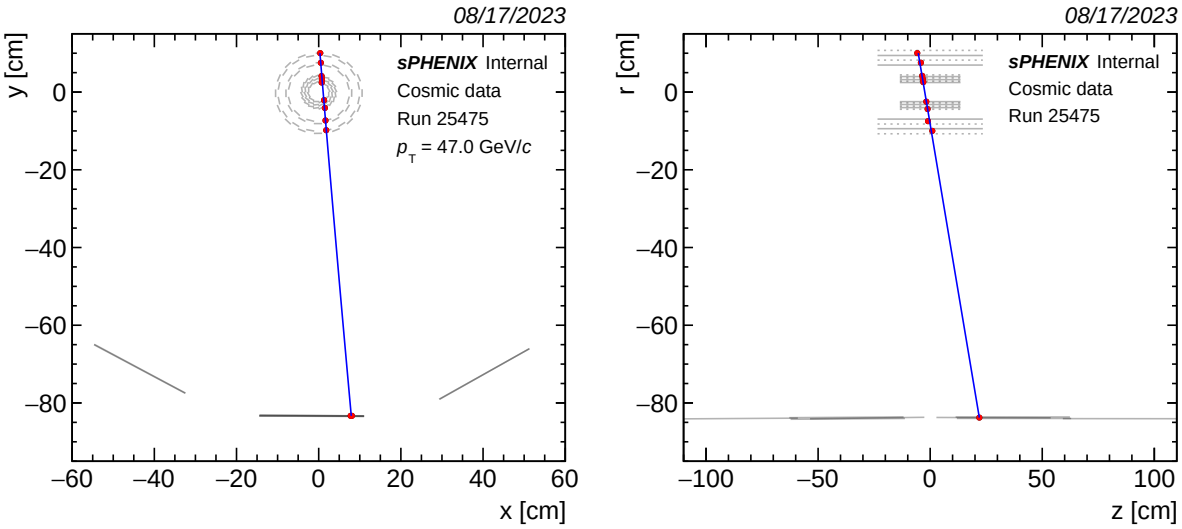

Figure 18: The 2-dimensional event display of MVTX, INTT, and TPOT of the event with BCO 885740684584: (Left) The cluster position and size in X-Y plane. (Right) The cluster position and size in Z-Radius plane.

Fig. 19, 20, 21 show the sPHENIX-style 3-dimension event display of the three cosmic candidates, BCO 883479809083, 883639102957, and 885740684584 with MVTX, INTT, and TPOT.

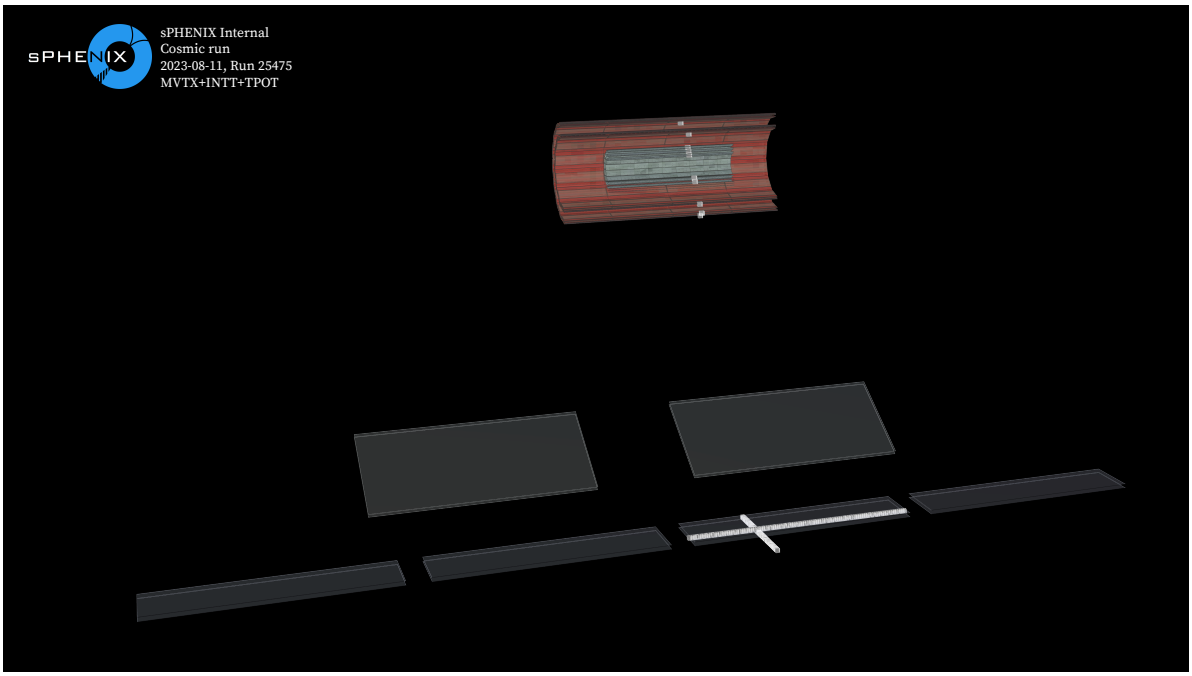

Figure 19: The 3-dimensional event display of MVTX, INTT, and TPOT of the event with BCO 883479809083.

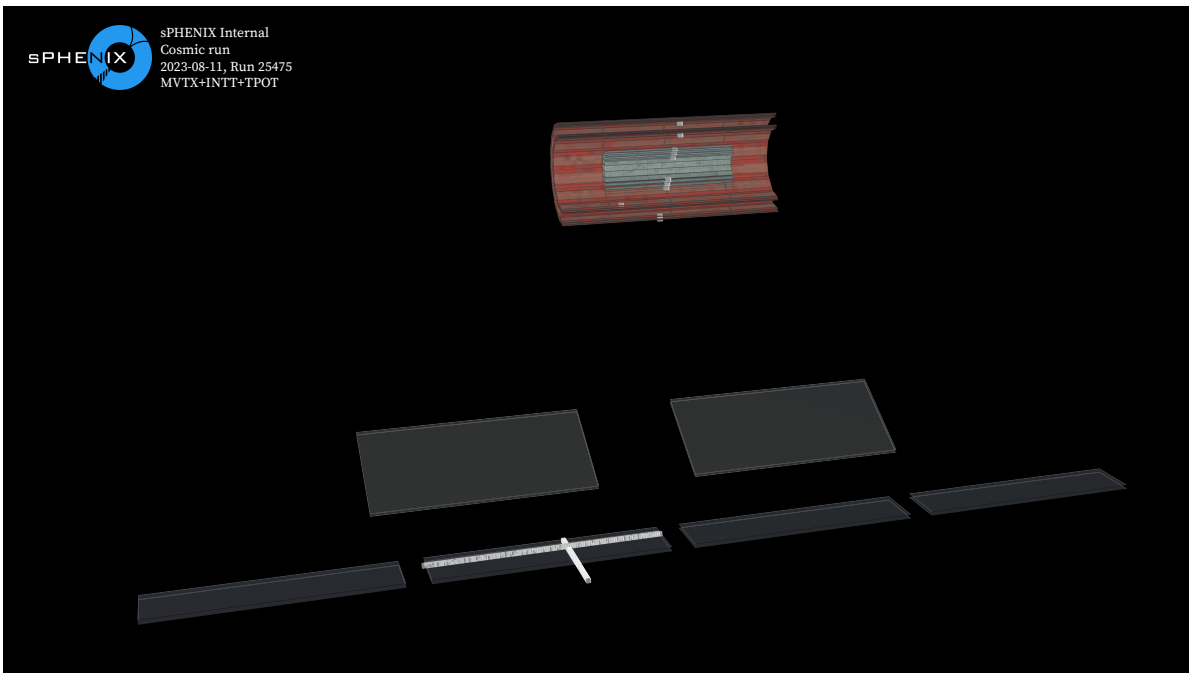

Figure 20: The 3-dimensional event display of MVTX, INTT, and TPOT of the event with BCO 883639102957.

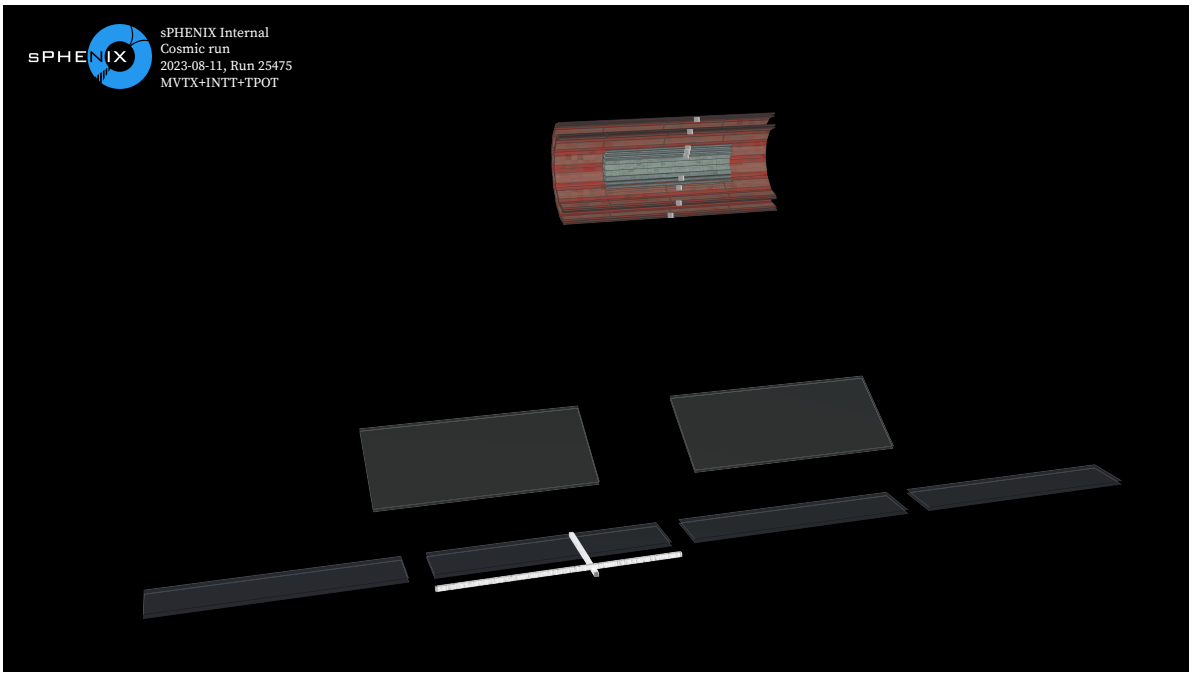

Figure 21: The 3-dimensional event display of MVTX, INTT, and TPOT of the event with BCO 885740684584.